ANT_G4 Monte Carlo

A Work in Progress

MC Components

- Previous Work

  - Physics/Neutrino/Cosmic Ray generator

  - Geometry

  - Hits output (truth)

- Recent work

  - Wire pulse simulation

  - ~5-7x improvement in speed

  - First attempts at reconstruction

Pulse Simulation

- Strategy is essentially Bruce's:

  - G4Step creates hit in LArgon active volume

  - Determine how many electrons are created in the hit

  - Determine in which wires the electrons induce a signal

  - Create wire pulses

  - Model output of pre-amp -> shaping->1st and 2nd stage filter in ADC counts

Electrons to Wires

- Number of electrons determined by W-value. Ignoring charge yield fluctuations. Fano only ~0.4 which is about <~5% error. Probably subdominant and not worthy of computation time.

- Recombination due to electron attachment: $Q = Q_o \times Exp(-t/t\_lifetime)$

- Charge assigned to wires using voxel method.
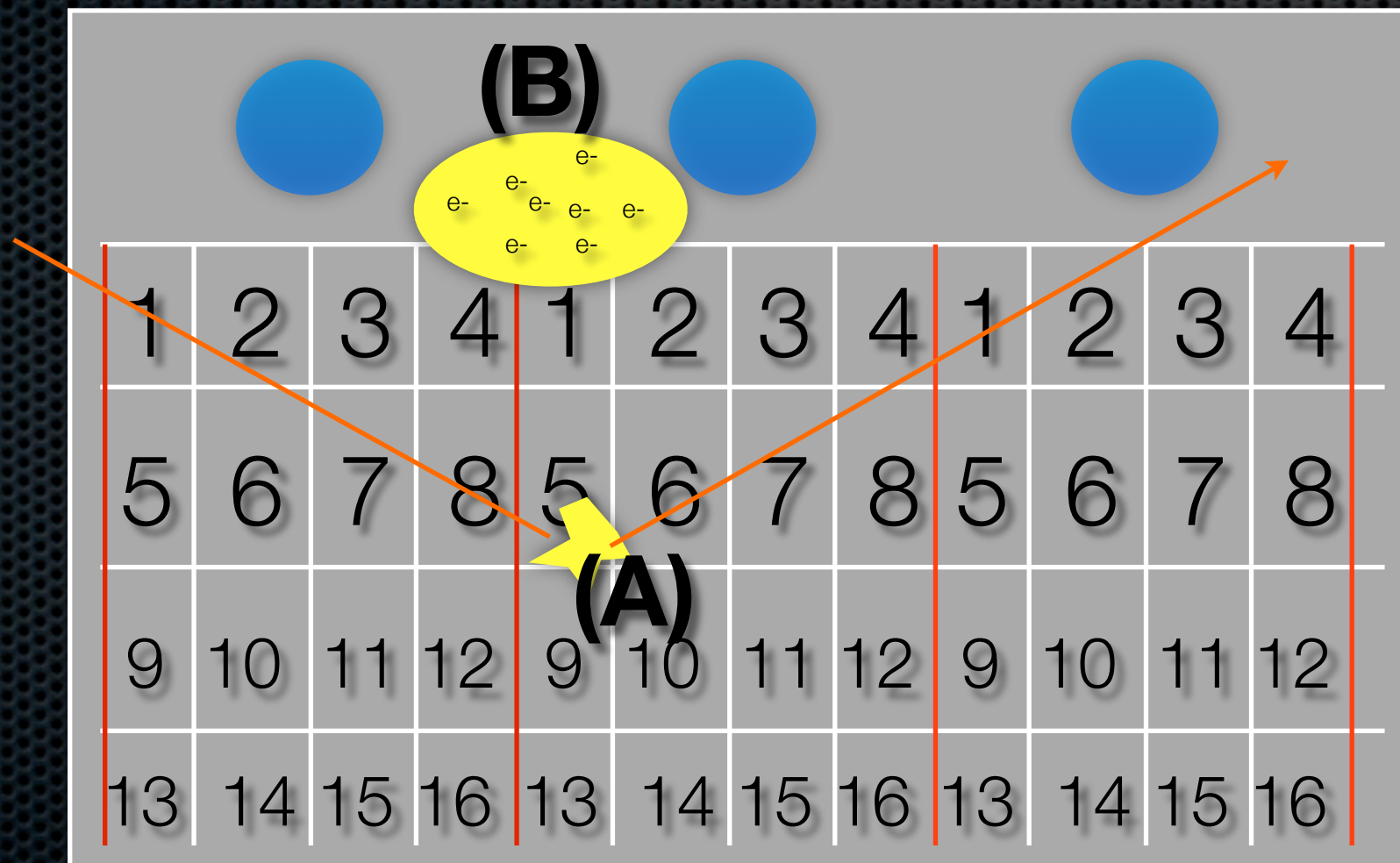
- (A) Find voxel where hit takes place

- (B) Use pre-calculated library to assign charges to wires in adc bin slices.

- Method sacrifices exact position of hit, but **reduces computation time** for one event down from 35 seconds to 3-5 seconds

Electrons to Wires
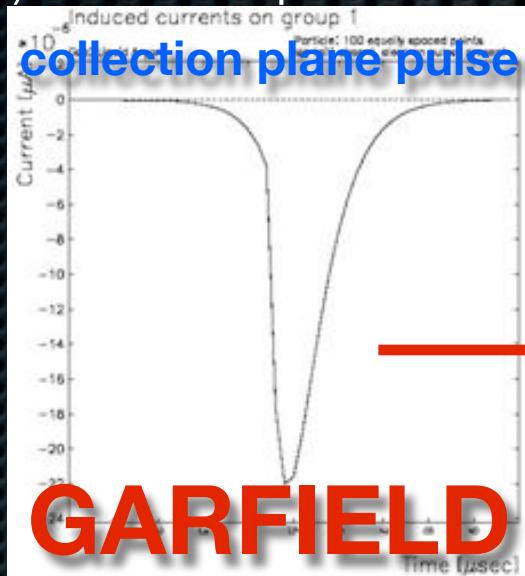
Voxel library example

fraction of total ionization created divided into 7 ADC bins

wire 0	0.000433	0.0119	0.109	0.335	0.351	0.126	0.0153	0.000613
wire 1	2.77e-05	0.000765	0.00697	0.0214	0.0225	0.00807	0.000978	3.93e-05

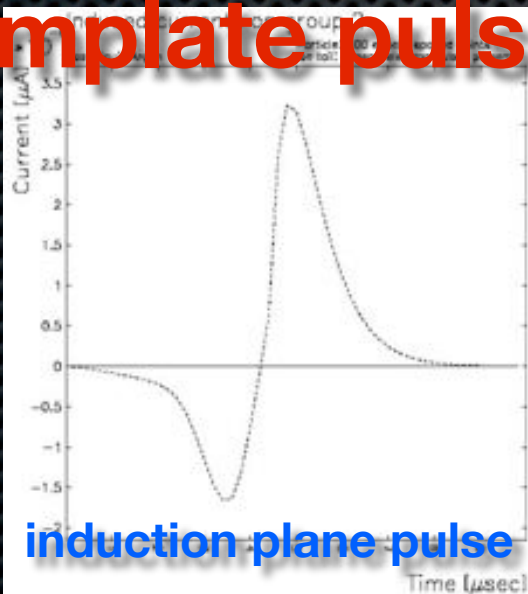Hits in this voxel share charge deposited between 2 wires

Charge distribution modeled by isotropic gaussian diffusion over 3-dimensions that originated from a point source. (accurate enough?)
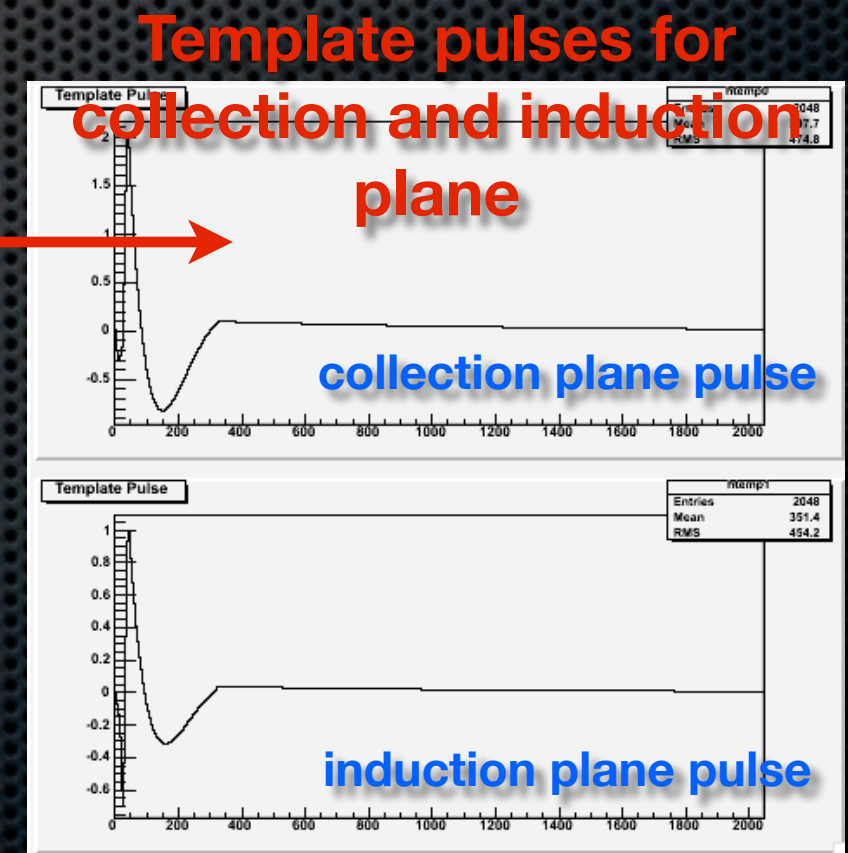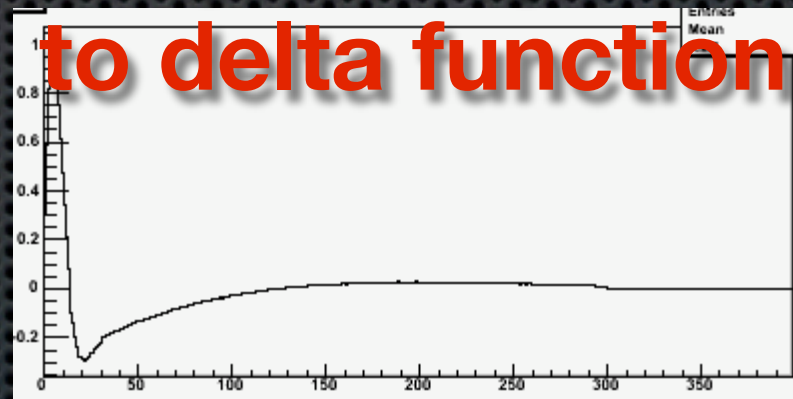
Pulse Shaping

Pulse shapes come from taking the template pulses produced by Bruce in GARFIELD and
(1) passing it through a software pre-amp (integrator with 200 microsecond decay), then
(2) convolve it with the output of the electronics response to a delta function (from Bruce and Dan)
(3) This shape is convolved with the charge pulses taken from GEANT

collection plane pulse

induction plane pulse

GARFIELD template pulses

Pre-Amp + Electronics output response to delta function

Template pulses for collection and induction plane

collection plane pulse

induction plane pulse

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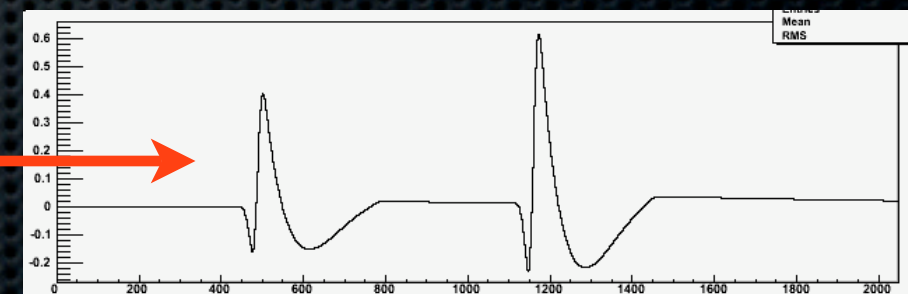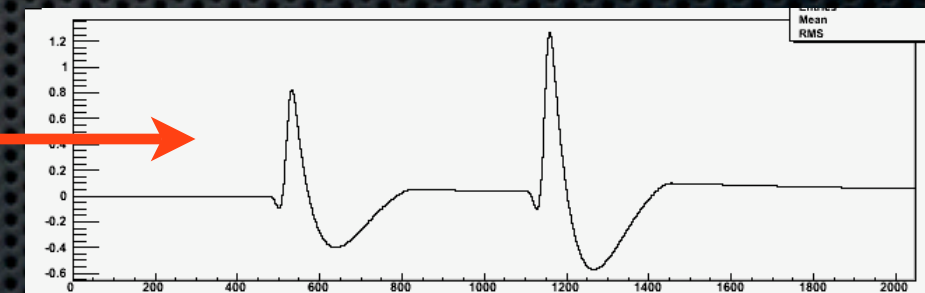(3) This shape is convolved with the charge pulses taken from GEANT
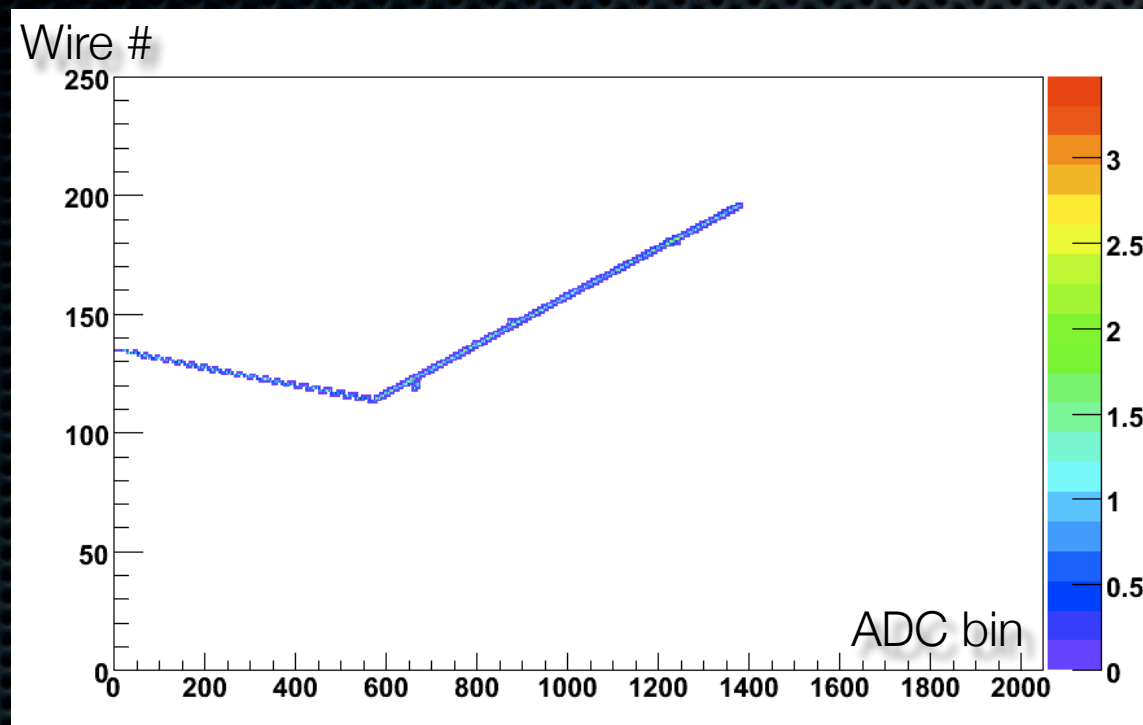

Charge pulses on wire from GEANT
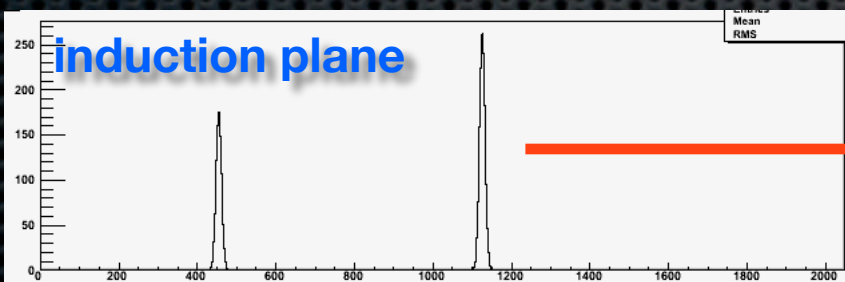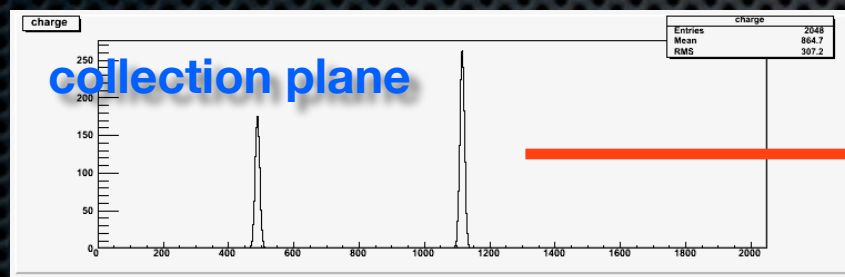
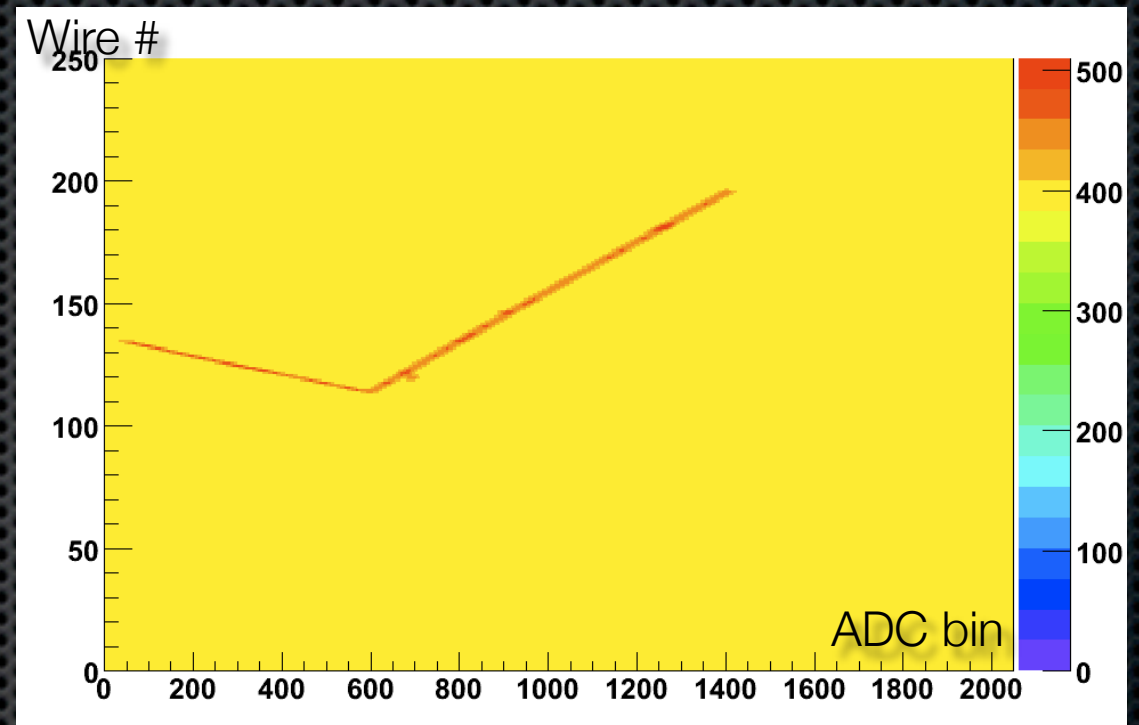Convoluted with electronics output pulse template
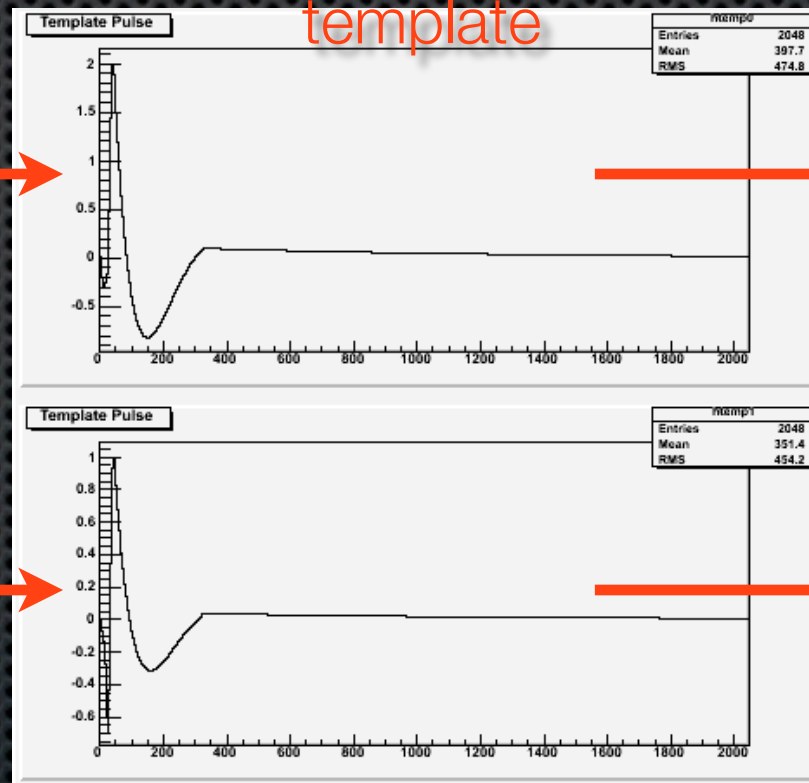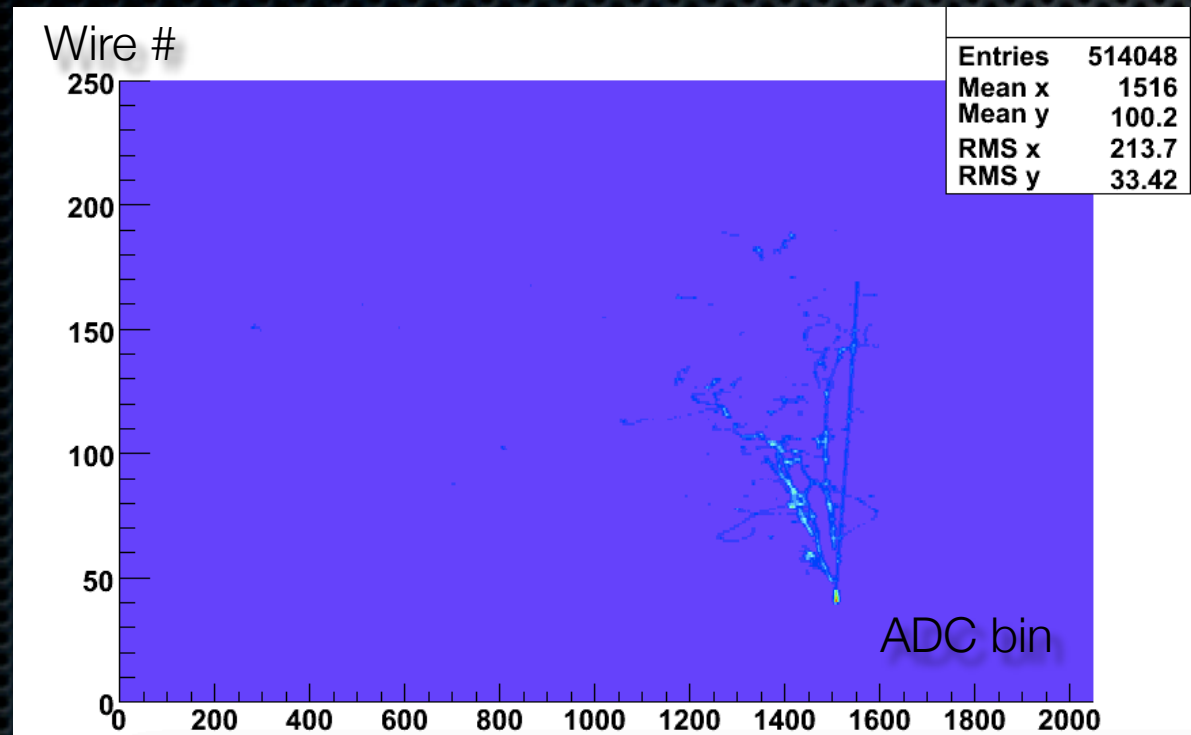
Simulated electronics output

Tracks

CCQE event: Charge deposited in an ADC bin for a given wire
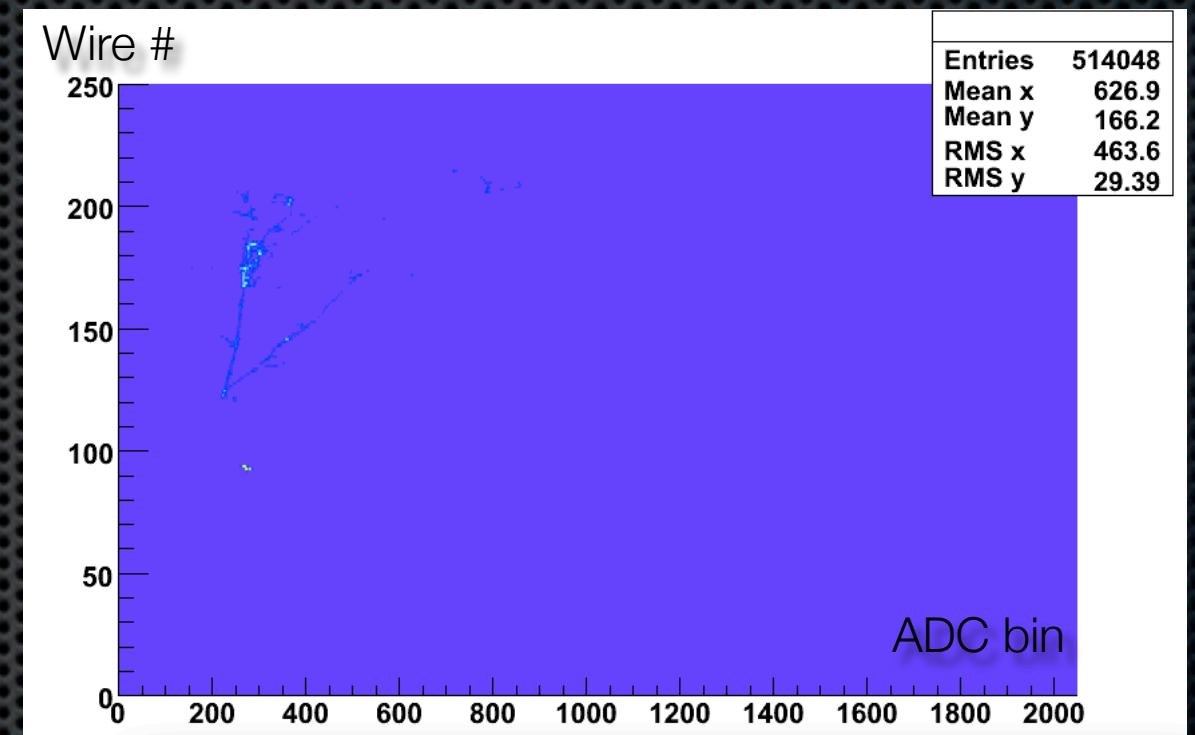Scale is in femtoCoulombs

Same CCQE event: Convolved wire pulses. Scale given in ADC counts
(with 400 ADC offset)

Scaling of pulses tweaked to give the the expected gain of 12 ADC counts per 1 fC of charge seen by the Pre-amp. Need to tune this once we have data.
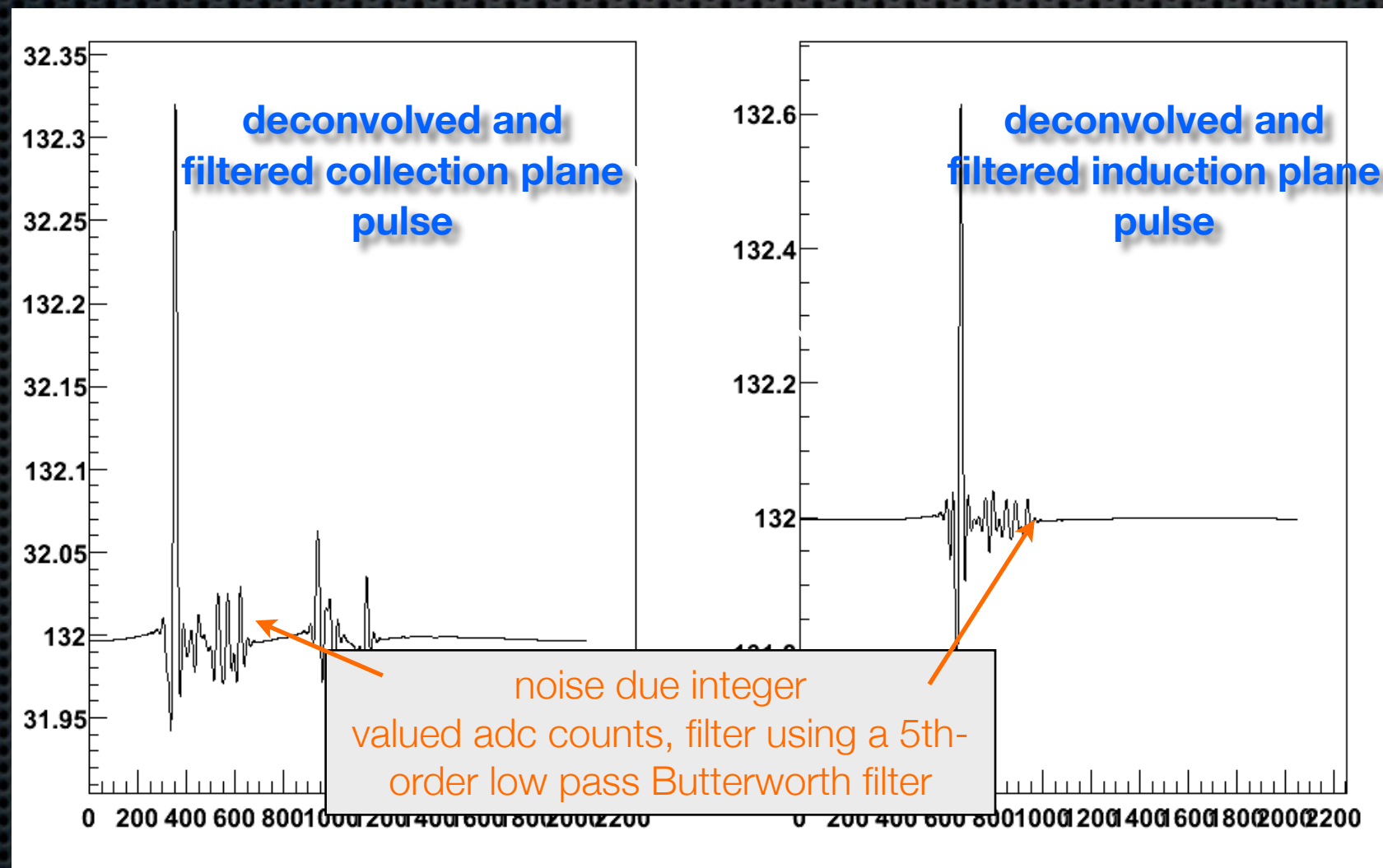
More Tracks

DIS event

Pi0 Event

On going

- Address my errors and simplifications

- Working on Reconstruction

  - Object-oriented shell in C++

  - Simple Reconstruction routine

  - Importing Bruce's pulse fitting library methods

  - Routine for pulse library creation from cosmic ray data?

Reconstruction

Deconvoluted electronics output by reversing pulse simulation steps and using a software filter to remove noise. (Noise due to the fact that electronics output is given by integer valued ADC counts)

deconvolved and filtered collection plane pulse

deconvolved and filtered induction plane pulse

noise due integer valued adc counts, filter using a 5th-order low pass Butterworth filter

Reconstruction

Simple 3-D Hit reconstruction